REMARKS

By the present amendment, claims 1 to 5 are pending in the application. Claim 1 is the only independent claim.

Support For Claim Amendments

Claim 1

In independent claim 1, support for "($0.36 \leq Ceq \leq 0.42$)" may be found in the specification, e.g., at page 6, lines 25-26 and lines 29-30.

Claim 5

In new dependent claim 5, support for the lower limit of Al being "0.012%" may be found, e.g., in the specification at Table 1, page 17, wherein in Inv. Steel D7 "0.012% Al" is the lowest Al content of the examples of the inventive steels of the present invention.

§103

Claims 1 to 4 were rejected under 35 U.S.C. §103(a) as being unpatentable over EP 1 221 493 to Kojima et al.

This rejection is respectfully traversed.

The Present Invention

The present invention relates to a high-strength thick steel plate excellent in low temperature toughness at HAZ resulting from large heat input welding, characterized by containing: C: 0.03 - 0.14%, Si: 0.30% or less, Mn: 0.8 - 2.0%, P: 0.02% or less, S: 0.005% or less, Al: 0.001 - 0.040%, N: 0.0010 - 0.0100%, Ni: 0.8 - 4.0%, Ti: 0.005 - 0.030% and Nb: 0.003 - 0.040%, and optionally further containing one or more of Ca, Mg, O, B, Cr, Mo, V and Cu, where Ni and Mn satisfy equation [1], and the balance of iron and unavoidable impurities:

$$Ni/Mn \geq 10 \times Ceq - 3 \ (0.36 \leq Ceq \leq 0.42) \quad \ldots\ldots [1]$$

$$\text{where, } Ceq = C + Mn / 6 + (Cr + Mo + V) / 5 + (Ni + Cu) / 15$$

and contains at least 100/mm^2 of oxide particles and having a equivalent circle diameter of 0.005 to 0.5µm.

Patentability

EP 1 221 493 ("EP '493")

The technology disclosed in EP '493 relates to a steel plate having yield strength not lower than 460 MPa and CTOD in HAZ not less than 02 mm at - 10°C, containing C: 0.04 - 0.14%, Si: 0.4% or less, Mn: 1.0 - 2.0%, P: 0.02% or less, S: 0.001 - 0.005%, Al: 0.001 - 0.01%, Ti: 0.005 - 0.03%, Nb: 0.005 - 0.05%, Mg: 0.0003 - 0.005%, O: 0.001 - 0.005%, and N: 0.001 - 0.01%, with the balance Fe and unavoidable impurities, and having TiN particles of 0.1 - 0.5µm at not less than 10,000 pieces/mm^2 containing oxides composed of Mg and Al and particles of 0.5 - 10µm at not less than 10 pieces/mm^2 containing not less than 0.3 wt% of Mn in the compounded form of oxide and sulfide.

Comparing the present invention and EP '493, although strength level (490 - 570 MPa grade) and the thickness level(more than 50 mm) are almost the same, the heat input of welding is quite different. Heat input of the present invention is 20 - 100 kJ/mm at 1 pass welding by electro-gas welding. On the other hand, EP '493 applies multi-layer sub-merged arc welding and the heat input is only less than 10 kJ/mm as shown in Table 2 of the example. The present invention targets to weld a 1 pass large heat input welding to secure HAZ toughness which is quite different from EP '493.

The present invention discovered that it is difficult to secure enough toughness only by refining the HAZ austenite grains by means of finely dispersed oxides, and it is necessary to improve toughness of the base steel matrix in case of a large heat input 1 pass welding such as electro-gas welding for high strength thick plate. More concretely, the

present invention adds Ni of 0.8% or more, and the Ni/Mn ratio defines a predetermined ratio in accordance with Ceq as defined in Equation [1], so as to obtain high toughness at the HAZ matrix. In EP '493, Ni is only optional. [0037] of EP '493.

On the other hand, EP '493 is a technology which applies multi-layer sub-merged arc welding and a small heat input which is less than 10 kJ/mm to improve HAZ toughness. As disclosed in EP '493: 1) refining GBF grains and FSP grains, 2) refining austenite (γ) grains in HAZ and FL by means of forming IGF grains, 3) reducing the amount of MA formation near HAZ. For 1) and 2), it is necessary to disperse TiN grains including oxides composed of Mg and Al, and for 3) it is necessary to limit the Nb content to less than 0.05% and further limit Cu + Ni + Cr + Mo to less than 3%. This means that the present invention does not carry out refining oxide grains and the present invention defines Equation [1] for achieving high toughness of HAZ matrix, which is not defined in EP '493.

Regarding Mg, the present invention does not require Mg. On the other hand, EP '493 requires a Mg addition as an indispensable element for achieving above mentioned 1) refining GBF grains and FSP grains, 2) refining austenite (γ) grains in HAZ near FL by means of forming IGF grains, 3) reducing the amount of MA formation near HAZ. Therefore, the present inventive steel is quite different from the steel composition disclosed in EP '493.

Regarding Equation [1], the calculation result: Ni/Mn - 10 x Ceq + 3 based on the examples of EP '493 is shown in the following Table 1. The resultant values for EP '493 are all negative. The means that all of the examples in EP '493 do not satisfy the Equation [1] (Ni/Mn $\geq$ 10 x Ceq - 3) defined in the present invention. It is submitted that the Equation [1] has patentability. The Office Action stated "there is no invention in the discovery of a

general formula if it covers a composition described in the prior art". The examples of EP '493 do not satisfy the defined Equation [1]. The steels disclosed or suggested in EP '493 do not achieve the required high toughness at HAZ matrix, as in the present invention.

Table 1

Calculation result: Ni/Mn-10×Ceq+3, of Examples in EP '493

Steel No.	C	Si	Mn	Cu	Ni	Cr	Mo	Nb	V	Ti	Ceq	Ni/Mn-10×Ceq+3
1	0.10	0.03	1.48	0.4	0.4	0	0.1	0.02	0	0.025	0.420	-0.93
2	0.08	0.02	1.53	0.5	0.5	0	0	0.02	0.01	0.017	0.402	-0.71
3	0.05	0.08	1.55	0.6	0.7	0	0	0.03	0	0.015	0.395	-0.50
4	0.09	0.06	1.55	0.6	0.6	0	0	0.03	0	0.016	0.428	-0.90
5	0.08	0.09	1.88	0.6	1	0	0	0.03	0	0.010	0.500	-1.47
6	0.10	0.08	1.57	0	0.4	0.4	0	0.02	0	0.009	0.468	-1.43
7	0.10	0.2	1.59	0.6	0.6	0	0	0.02	0	0.009	0.445	-1.07
8	0.11	0.25	1.60	0	0	0	0	0.04	0	0.008	0.377	-0.77
9	0.11	0.25	1.60	0	0	0	0	0.04	0	0.008	0.377	-0.77
10	0.13	0.25	1.10	0	0	0	0	0.04	0	0.006	0.313	-0.13

Regarding the features of TiN grains and oxides, EP '493 defines that TiN particles of 0.01 - 0.5 μm at not less than 10,000 pieces/mm^2 containing dispersed oxide composed of Mg and Al. On the other hand, the present invention contains and disperses at least 100/mm^2 of oxide particles. (Claim 2) Although EP '493 contains oxide, EP '493 mainly contains TiN, which is a different role than the present invention. As disclosed in the present specification, the amount of dissolved oxygen of the steel melt is adjusted to 0.0010 - 0.0050% in the deoxidation process, then first deoxidizing the steel melt with Ti, and then deoxidizing the steel melt with Al, and further adding one or more of Ca, Mg and REM. This process is quite different from the technology disclosed or suggested in EP '493.

It is therefore submitted that claim 1, and all claims dependent thereon, are patentable over EP '493.

With respect to new dependent claim 5 which requires a <u>minimum</u> of 0.012% Al, EP '493 has a <u>maximum</u> of 0.01% Al. Therefore, new dependent claim 5 is further patentable over EP '493.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed to issue.

Respectfully submitted,

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